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# Multinational Firms and Technology Transfer

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A developing country may attract foreign direct investment (FDI) for (1) technology transfer that increases local firm profits or for (2) wage premiums that benefit workers. The two never occur together but if the country can attract FDI, it is guaranteed either the technology transfer or the greater pay for workers — although those benefits may not be great enough to make FDI more attractive than exporting.



## Summary findings

Glass and Saggi construct an oligopoly model in which a multinational firm has a technology superior to those of local firms in the host country. Workers employed by the multinational acquire knowledge of the superior technology and can spread their knowledge to local firms by switching employers. The multinational chooses to pay a wage premium to prevent local firms from hiring away its workers if the local firms are sufficiently disadvantaged or if there are enough local firms.

Diffusion of the superior technology benefits local firms at the expense of workers, whose wages suffer.

The host government might have an incentive to attract foreign direct investment even when technology transfer will not result, because of the wage premium local employees of the multinational firm earn.

Also, foreign direct investment with technology transfer may reduce the total economic rent the host country earns.

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This paper — a product of Trade, Development Research Group — is part of a larger effort in the department to better understand the role of multinational firms in international technology transfer. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Lili Tabada, room MC3-333, telephone 202-473-6896, fax 202-522-1159, Internet address [ltabada@worldbank.org](mailto:ltabada@worldbank.org). Policy Research Working Papers are also posted on the Web at <http://www.worldbank.org/html/dec/Publications/Workpapers/home.html>. Kamal Saggi may be contacted at [ksaggi@worldbank.org](mailto:ksaggi@worldbank.org). February 1999. (32 pages)

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# Multinational Firms and Technology Transfer

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## 1 Introduction

Technology can be transferred across countries through many channels (such as technology licensing, joint ventures, and imports of capital goods), but foreign direct investment (FDI) is one of the most important.<sup>1</sup> By encouraging multinationals to establish local production facilities, developing countries hope to generate technological transfer to local firms. Such transfers may occur through a variety of channels: the presence of multinational firms may facilitate imitation (Glass and Saggi 1998a and 1998b) or have more general contagion effects (see Findlay 1978).<sup>2</sup>

While product imitation has been extensively studied, the role of labor movement as a channel of technology transfer across firms has been largely neglected. This channel differs from others because technology moves across firms through the physical movement of workers who have been exposed to the technology. The goal of this paper is to capture the role of labor movement as an endogenous mechanism of technology transfer and examine the implications of this transfer for total economic rent earned by the host country.

In our benchmark model, a source firm establishes production facilities in a host country, and the source firm then competes with a host firm in a common external market.<sup>3</sup> The host firm may gain access to the source firm's superior technology by hiring workers away from its workers. Anticipating the possible raiding of its work force, the source firm may choose to pay a wage premium to keep the host firm from gaining access to its technology. The source firm weighs the cost of paying higher wages against the benefit of limiting technology transfer to the host firm. Thus, our benchmark model determines whether technology transfer will occur, given that the source firm

<sup>1</sup>According to the *World Investment Report*, 1992, transactions between parent firms and their subsidiaries in royalties and license fees (mostly receipts for the use of trademarks, processes, techniques, copyrights, and patents) account for over 80% of international technology transactions.

<sup>2</sup>Glass and Saggi (1998b) address the potential for dynamic benefits from FDI and substitution between channels of international technology transfer. See Pack and Saggi (1997) for further discussion of the role multinationals play in international technology diffusion.

<sup>3</sup>The host country serves as an export platform for the multinational. Many countries encourage multinationals to invest in their economies, especially when a large share of their output is exported to the world market.

chooses to produce in the host country.

Next, we extend the model to allow the source firm the possibility of locating in a more expensive location where physical separation protects against the spread of its technology to its rivals. Three different types of equilibria are possible in this general model: exporting, FDI with technology transfer, and FDI with no technology transfer. Both exporting and preventing technology transfer under FDI raise the source firm's costs relative to allowing technology transfer under FDI. However, the wage premium required to prevent technology transfer is crucially linked to the benefits of the technology to the host firm, whereas the added cost under exporting is not. Our model isolates the circumstances under which a multinational chooses to pay a wage premium - or refrains from FDI - to preserve its technological superiority.

The wage premium paid by the source firm decreases with the host firm's productivity disadvantage, so total economic rent in the host economy is higher under technology transfer (than no transfer) when the source firm enjoys a relatively large productivity advantage. However, a source firm chooses to curb technology transfer precisely when it enjoys a sufficient productivity advantage over the host firm. Hence, the goals of the host country and the source firm commonly clash, leading to a motive for an active host government policy.

Our model isolates circumstances under which FDI inducing policies, like those witnessed in many developing and formerly communist countries, do indeed raise economic rents in the host economy. Our model indicates that total economic rent can increase due to FDI even if technology transfer is not achieved: to prevent transfer, the source firm pays a wage premium that benefits host workers.<sup>4</sup> Indeed, technology transfer is not necessarily optimal for the host economy: FDI by the source firm lowers the source firm's marginal cost relative to exporting and may hurt the host firm even though the host firm also experiences a decline in marginal cost (due to technology transfer).

In a simplistic model, FDI inducing policies would not occur in the absence of technology transfer. FDI would lower the source firm's cost without lowering the host firm's cost. As a result, host firm profits would be harmed. Here, the wage premiums paid to prevent technology transfer provide an

<sup>4</sup>Glass and Saggi (1998c) provide a related argument based on general equilibrium effects rather than attempts to limit technology diffusion.

offsetting component of total economic rent.

Evidence on labor movement from multinationals to host firms is consistent with our model. Labor movement from multinationals to host firms occurs predominantly in more developed countries, where multinationals do not have as substantial an advantage over host firms. Gershenberg (1987) finds evidence of only minor labor movement from multinationals to Kenyan firms: only 16% of the job shifts involved movement from multinationals to host firms. Bloom (1992) finds substantial technological transfer in South Korea when production managers left multinationals to join host firms; Pack (1997) notes similar findings for Taiwan.<sup>5</sup>

Evidence documenting that multinationals pay higher wages than host firms is also consistent with our model. These wage differentials are usually larger in less developed countries, where multinationals are more advantaged relative to host firms. Using data from Mexico, Venezuela, and United States, Aitken, Harrison, and Lipsey (1995) show that higher levels of FDI are associated with higher wages in all three countries. In the two developing countries, they find no evidence of higher wages paid by host firms. Thus, multinationals pay higher wages than host firms in these developing countries.

While the potential importance of technological transfer from multinationals is widely recognized, few rigorous models examine this process of technology transfer across firms. The main exception is Ethier and Markusen (1996).<sup>6</sup> Our paper differs from theirs in many key areas. First, we examine the transfer of process (rather than product) technology. Thus, even when technology is not transferred to the host firm, the host firm can still produce using an inferior technology. The source firm always faces competition: the issue is the strength of competition. We explore the implications of partial technology transfer, where the host firm remains disadvantaged relative to the multinational even once it has raided the multinational's work force.<sup>7</sup> Second, we achieve some intriguing implications of technology transfer for total economic rent earned by the host country. In Ethier and Markusen's

<sup>5</sup>Considering workers that left multinationals in the mid 1980s, almost 50% of all engineers and approximately 63% of all skilled workers left to join host firms.

<sup>6</sup>See also Dunning (1981), Ethier (1986), and Horstmann and Markusen (1992) for the choice of entry mode between exporting, FDI, and licensing.

<sup>7</sup>This partial technology transfer stems from some forgetting by workers or lack of perfect suitability of the technology for the host firm (limited absorptive capacity).

model, technology transfer is curtailed by a lump-sum payment to the local partner, so technology transfer is prevented precisely when lack of technology transfer is in the interest of the local partner. In our model, however, the workers are paid the premium to curtail technology transfer, so the benefit of technology transfer to the local firm (or the local economy) need not exactly equal the premium paid to the workers. Much of importance depends on this divergence between the interests of the host workers and the host firm. We discuss the implications of technology transfer for total economic rent earned by the host country and draw policy conclusions.

Taylor (1993) allows firms to disguise their technology to limit technology transfer through imitation. Such strategies are important for product innovations, where knowledge of the technology is embedded in the product and can be discovered through reverse engineering. Here, the superior technology takes the form of process innovation (lower cost of production), where knowledge of the technology is embodied in the workers rather than the product. Thus, we share the desire to endogenize the degree of technology transfer, but due to the different technology considered, the strategy used to control technology transfer differs.

Our argument is related to the idea that firms may take actions to raise their rival's costs in Salop and Scheffman (1987). However, in our model host firms can escape the cost increase by choosing to employ uninformed workers rather than raiding the multinational's work force. Our analysis adds an active role for host firms in countering the cost increase. In the equilibrium of our model, the costs of host firms are always less than or equal to the costs they would face in the absence of the source firm.

Section 2 develops our basic model of technology transfer through labor movement across firms. Section 3 examines the implications of this model for total economic rents earned by the host country. Section 4 extends the model to allow for the possibility of exporting and considers the implications of exporting relative to FDI for host country rents. Section 5 uses the insights delivered by the models to shed some light on policy issues. Section 6 extends the model for the case of multiple host firms. Section 7 concludes.

## 2 A Model of Technology Transfer

A source ( $S$ ) firm and a host ( $H$ ) firm produce a homogeneous good and compete as Cournot oligopolists. All output is exported to the world market where the demand function is given by  $p(Q)$ ,  $p' < 0$  and  $p'' < 0$ . The source firm has a superior technology for producing the good: to produce a unit of output, it requires less labor than a host firm.

Each firm has constant returns to scale production technology. Workers employed by the source firm acquire knowledge about its technology, which can be partially transferred to the host firm if they switch employers. To produce one unit of output, the source firm needs one unit of labor (by normalization). Any workers the multinational employs are exposed to its technology. Since we focus on whether the multinational chooses to prevent the departure of its workers to the host firm, we assume the exposure of workers to technology is immediate and cannot be prevented.<sup>8</sup> Workers are considered *informed* if they have knowledge of the superior technology (through employment at the source firm) and *uninformed* otherwise. To produce one unit of output, the host firm needs  $\theta$  units of informed labor or  $\Theta$  units of uninformed labor, where technology transfer enhances a host firm's productivity  $\theta < \Theta$ . Define the relative labor requirement for the host firm as  $\Gamma \equiv \frac{\Theta}{\theta} > 1$ .

Further assume technology transfer remains incomplete. Although having worked for the source firm raises a worker's productivity when working for the host firm, the source firm's superior technology is only partially transferable. The worker remains more productive when employed by the source firm than when employed by the host firm  $\theta > 1$ . The source firm maintains an advantage because some aspects of its advantage (such as superior management and organization) are located in its headquarters and thus unavailable to the host firm. Also, workers may forget some aspects of the technology upon leaving the source firm.

Workers are identical except for whether they are initially employed by the source firm. If not employed by this industry, all workers can earn a wage equal to one (by normalization) elsewhere in the economy, as knowledge of

<sup>8</sup>Technology transfer differs from general training in several important ways. With general training, the firm has a choice whether or not to provide the training. Such training also involves costs, and replacing trained workers with untrained workers would lower productivity at the firm.



the source firm's superior technology is irrelevant in other industries.<sup>9</sup> Thus, firms face a perfectly elastic supply of uninformed labor at the given host wage.

Our basic model is broken into three stages. In the first stage, the source firm chooses the wage it offers to its workers.<sup>10</sup> In the second stage, the host firm chooses the wage it offers the multinational's workers (given the wage offered by the multinational). In the third stage, the firms compete as Cournot oligopolists and the game ends.

Our assumption regarding the timing of wage offers reflects the view that the multinational should have a first-mover advantage when dealing with its own workers relative to the host firm. Second, we assume that workers arrive at the multinational, see its superior technology and instantaneously gain the requisite knowledge that increases their productivity at the host firm. This assumption captures the idea that the time required to observe a new technology is extremely short relative to the length of time during which the multinational must protect its technological advantage. These two assumptions allow us to focus on the source firm's incentive to curtail the spread of knowledge that would strengthen its rivals.

## 2.1 Output Stage

We analyze the sub-game perfect equilibrium of this model through backward induction. Consider the output stage. Let the output of firm  $i$  be given by  $q_i$ , where  $i = S, H$ , and let total output be  $Q = q_H + q_S$ .<sup>11</sup> Each firm  $i$  picks its quantity  $q_i$  to maximize its profits

$$\pi_i = [p(Q) - c_i] q_i \quad (1)$$

given the quantity chosen by other firm. The standard first order conditions for profit maximization equate marginal revenue and marginal cost (given

<sup>9</sup>To the extent that the superior technology is also useful in other industries, host welfare under technology transfer would be higher but the multinational's decision whether to permit technology transfer would not be affected.

<sup>10</sup>We do not permit more complicated wage structures that would permit employees to bond themselves to the multinational by paying an up front fee that would be sacrificed if they leave the multinational to work for a local competitor. Such wage structures are impeded by lack of access of workers to credit markets.

<sup>11</sup>Subscripts  $i \in \{H, S\}$  denote type of firm: host or source.

the output of the other firm)

$$\frac{\partial \pi_i}{\partial q_i} = p(Q) + q_i p'(Q) - c_i = 0 \quad (2)$$

The second order conditions are  $\partial^2 \pi_i / \partial q_i^2 = 2p'(Q) + q_i p''(Q) < 0$ . The equilibrium outputs of the firms solve the first order conditions (2). The marginal cost of each firm depends on whether technology transfer occurs.

## 2.2 Wages and Technology Transfer

Consider the wage decision of the host firm. Denote the wage offered by the source firm by  $w_S$ . Workers choose to continue working for the source firm unless the host firm bids them away by offering a higher wage. By offering a wage arbitrarily above the source firm's wage, the host firm can lure away workers from the source firm. Given our assumptions regarding the two types of workers and the nature of the production technology, the host firm's optimal response has a simple structure of matching the source firm's wage unless it exceeds the level such that uninformed workers become a better value.<sup>12</sup>

**Lemma 1** *The host firm matches the source firm's wage  $w_H = w_S + \varepsilon$  for informed workers if the source firm's wage is sufficiently low  $w_S < \Gamma$  or offers  $w_H = 1$  to uninformed workers if the source firm's wage is sufficiently high  $w_S \geq \Gamma$ .*

For any wage  $w_S$  the source firm offers, the host firm hires informed or uninformed workers, depending on which is the cheaper method of production.<sup>13</sup> When the host firm hires uninformed workers, it pays them the wage (normalized to one) earned in elsewhere in the economy, whereas when it hires workers away from the source firm, it must beat the wage being paid by the source firm. Our assumptions regarding the perfectly elastic supply of *uninformed* workers and instantaneous knowledge transfer to workers imply that if the host firm decides to match the wage of the source firm, it faces a perfectly elastic supply of *informed* workers.<sup>14</sup>

<sup>12</sup>Proofs are provided in the Appendix.

<sup>13</sup>By convention, at  $w_S = \Gamma \equiv \frac{\Theta}{\theta}$ , host firms hire only uninformed workers.

<sup>14</sup>In the absence of these assumptions, the analysis would be considerably more difficult and would detract from our main points without adding any crucial features.

Next consider the wage decision of the source firm. Given Lemma 1, the source firm can curtail labor movement by offering the wage  $w_S = \Gamma$ .<sup>15</sup> We analyze whether paying a wage premium to prevent technology transfer raises the source firm's profits. Proposition 1 below indicates that the source firm's decision depends crucially upon the extent that technology transfer to the host firm is incomplete (the magnitude of  $\theta$ ).

In the *no technology transfer* (N) equilibrium, the source firm's marginal cost equals  $c_S^N = \Gamma > 1$  and the host firm's marginal cost equals  $c_H^N = \Theta > \theta$ . In the *technology transfer* (T) equilibrium, the source firm's marginal cost equals one  $c_S^T = 1$  and the host firm's marginal cost equals  $c_H^T = \theta$ . We denote each profit function  $\pi_i^j$  by  $\pi_i^j(c_S^j, c_H^j)$  to highlight the marginal cost of each firm under each equilibrium  $j$ ,  $j \in \{N, T\}$ .<sup>16</sup>

As depicted in Figure 1, both  $\pi_S^T(1, \theta)$  and  $\pi_S^N(\Gamma \equiv \frac{\Theta}{\theta}, \Theta)$  are strictly increasing in  $\theta$ : source firm profits are higher when technology transfer is more partial in nature.<sup>17</sup> Second, at the lower boundary where  $\theta = 1$ , source firm profits under technology transfer  $\pi_S^T(1, 1)$  exceed source firm profits under no technology transfer  $\pi_S^N(\Theta, \Theta)$ . In a Cournot equilibrium where firms have constant marginal costs, a uniform increase in the cost of all firms lowers profits of each firm. Finally, at the upper boundary where  $\theta = \Theta$ ,  $\pi_S^T(1, \Theta) = \pi_S^N(1, \Theta)$ : both firms have the same marginal cost under technology transfer and no technology transfer, so source firm profits do not depend on whether technology transfer occurs.

<sup>15</sup>Any further increase in wages only increases the source firm's cost without affecting the host firm's cost and hence would be counterproductive.

<sup>16</sup>Superscripts  $j \in \{N, T\}$  denote the type of equilibrium: FDI with no technology transfer, or FDI with technology transfer.

<sup>17</sup>Source firm profits under technology transfer increase in  $\theta$  due to the higher cost of the host firm

$$\frac{\partial \pi_S^T(1, \theta)}{\partial \theta} = p' \frac{\partial q_H^T}{\partial \theta} q_S^T > 0$$

Also, source firm profits under no technology transfer increase in  $\theta$  due to the lower cost of the source firm

$$\frac{\partial \pi_S^N(\frac{\Theta}{\theta}, \Theta)}{\partial \theta} = \left[ p' \frac{\partial q_H^T}{\partial \theta} + \frac{\Theta}{\theta^2} \right] q_S^N > 0.$$

For both technology transfer or no technology transfer to occur for some values of  $\theta$ , there must be a *source firm threshold*  $\theta_S$  where source firm profits are the same under technology transfer and no technology transfer

$$\pi_S^T(1, \theta_S) = \pi_S^N\left(\frac{\Theta}{\theta_S}, \Theta\right) \quad (3)$$

We are assured of at least one intersection between the two profit functions (the existence of a threshold  $\theta_S$  where  $1 < \theta_S < \Theta$ ), if the source firm profit function under technology transfer (plotted against  $\theta$ ) meets the source firm profit function under no technology transfer from below at the upper boundary  $\theta = \Theta$ :

$$\frac{\partial \pi_S^T(1, \Theta)}{\partial \theta} > \frac{\partial \pi_S^N(1, \Theta)}{\partial \theta} \quad (4)$$

We assume the above condition is satisfied so that the source firm curtails technology transfer for sufficiently high values of  $\theta$ .<sup>18</sup>

**Proposition 1** *If  $\theta \geq \theta_S$ , the source firm offers the wage  $w_S^N = \Gamma$  and the no technology transfer equilibrium occurs, whereas for all  $\theta < \theta_S$ , the source firm offers the wage  $w_S^T = 1$  and the technology transfer equilibrium occurs.*<sup>19</sup>

The above result says that the multinational curtails technology transfer precisely when technology transfer to the local firm is highly incomplete ( $\theta$  is large). When  $\theta$  is large, the multinational has to pay a small premium to curtail turnover. If  $\Theta$  is large enough, this strategy is worthwhile. For the case of linear demand, the source firm threshold is simply  $\theta_S = 2$ .<sup>20</sup>

<sup>18</sup>Using the first order conditions (2) and noting that  $q_S^T = q_S^N$  when  $\theta = \Theta$ , condition (4) is equivalent to

$$\frac{\partial q_H^T}{\partial \theta} > \frac{\partial q_H^N}{\partial \theta} + \frac{1}{p'}$$

The above condition requires that an increase in  $\theta$  has a stronger positive effect on the host firm's output under the  $N$  equilibrium than under the  $T$  equilibrium. Equivalently, an increase in a firm's own cost must have a larger negative impact on its output than a decrease in its rival's cost.

<sup>19</sup>This proposition rules out multiple intersections of the two profit functions.

<sup>20</sup>We require  $\Theta > \hat{\theta}_S$  so that there exists a range over which the source firm prefers to prevent technology transfer.

How does the host firm fare under the two equilibria? A host firm enjoys higher profits in the technology transfer equilibrium than in the no technology transfer equilibrium  $\pi_H^T \geq \pi_H^N$ . To see the logic of this result, suppose the source firm pays some wage  $w_S$  and the host firm chooses to match that wage. We show in the Appendix that, in such a situation, a host firm suffers a bigger increase in marginal cost than the source firm for a given wage increase since technology transfer remains partial  $\theta > 1$  and its profits are strictly decreasing in  $w_S$ , regardless of its magnitude. Therefore, a host firm's profits are lower under the no technology transfer equilibrium than the technology transfer equilibrium, as its profits decline in the wage paid by the source firm.

Thus, a clear conflict emerges between the interests of the source firm and the host firm: the source firm prefers no technology transfer when its advantage is substantial (for  $\theta \geq \theta_S$ ), while the host firm always prefers technology transfer. More surprising is that the interests of the (host) workers fall in line with those of the source firm, not the host firm.

### 3 Technology Transfer and Economic Rents

Define total economic rent in equilibrium  $j$  as the host firm's profits and any wage premium<sup>21</sup>

$$W^j \equiv \pi_H^j + B^j \quad (5)$$

where the total wage premium is

$$B^j \equiv (w_S^j - 1) q_S^j \quad (6)$$

Workers can gain employment at the market wage of one elsewhere in the economy, so only wage premiums (wages greater than one) enter into host economic rents.

No wage premium is paid in the technology transfer equilibrium  $B^T = 0$ , while the wage premium is positive in the no technology transfer equilibrium  $B^N \equiv (\Gamma - 1) q_S^N > 0$ . While the host firm suffers lower profits in the no

<sup>21</sup>All output is exported, so consumer surplus effects are absent. Having some of the good were consumed in the host country would affect host welfare, but not the decision of the source firm over whether to prevent technology transfer.

technology transfer equilibrium, workers enjoy a wage premium. Therefore, from the viewpoint of the host economy, either equilibrium could dominate.

From Proposition 1, we know that the technology transfer equilibrium is obtained whenever  $\theta < \theta_S$  while the no technology transfer equilibrium is obtained whenever  $\theta \geq \theta_S$ . Since host firm profits decline with  $\theta$  under technology transfer, total economic rents earned by the host country under the technology transfer equilibrium decrease with  $\theta$ . However, economic rents under the no technology transfer equilibrium are affected by  $\theta$  in a more interesting fashion.

$$\frac{dW^N}{d\theta} = \frac{d\pi_H^N}{d\theta} + \frac{dB^N}{d\theta} \quad (7)$$

The first term captures the decrease in host economic rents due to a decrease in the profits of the host firm, while the second term captures the effect on the wage premium paid by the source firm. In the Appendix, we demonstrate that the total effect is negative if  $\eta < 1$ , where  $\eta \equiv \frac{d \ln q_S^N}{d \ln \theta}$  is the elasticity of the source firm's optimal output with respect to the disadvantage of the host firm.

**Lemma 2** *If  $\eta < 1$ , then the total wage premium  $B^N$  paid by the source firm in the no technology transfer equilibrium decreases and host economic rents decline as the host firm's disadvantage widens ( $\theta$  increases).*

On the one hand, an increase in  $\theta$  lowers the wage premium that the source firm has to pay to curtail labor movement (direct wage effect), while on the other hand a higher  $\theta$  also shifts market share in favor of the source firm so that its output increases, leading to an increase in the total wage bill (indirect output effect). When  $\eta < 1$ , the direct wage loss dominates the indirect gain from the increased output of the source firm. Assume that  $\eta < 1$ , so a greater disadvantage of the host firm implies a lower wage bill and lower host economic rents. Thus, host economic rents decline under both equilibria as  $\theta$  increases.

When the magnitude of potential technology transfer disappears  $\theta = \Theta$ , the wage premium under the no technology transfer equilibrium equals zero so host economic rents just equals the host firm's profits  $W^N = \pi_H^N$ . As illustrated in Figure 2, since the host firm's profits under the two equilibria are the same when  $\theta = \Theta$ , the host economy's rent is the same under the two

equilibria. Suppose that the two curves representing economic rents under technology transfer and economic rents under no technology transfer intersect at some *host rents threshold*  $\theta_W$ :  $W^T = W^N$  for  $\theta = \theta_W$  and  $W^T \geq W^N$  iff  $\theta \geq \theta_W$ . For this threshold to exist, host rents under no technology transfer must exceed host rents under technology transfer  $W^N > W^T$  at the lower boundary  $\theta = 1$ .<sup>22</sup>

Viewing the effects of technology transfer on source firm profits and host economic rents indicates the potential for the objectives of the host country and the source firm to clash. This clash is likely because the source firm prefers the no technology transfer equilibrium whenever  $\theta$  is large, which is when host economic rents increase due to technology transfer.

**Proposition 2** *If  $\theta_S = \theta_W$ , the source firm prevents technology transfer precisely when host economic rents are higher with technology transfer. If  $\theta_S \neq \theta_W$  and  $\theta < \min\{\theta_S, \theta_W\}$ , technology transfer from the source firm lowers host economic rents whereas when  $\theta > \max\{\theta_S, \theta_W\}$ , preventing technology transfer lowers host economic rents. Lastly, when  $\max\{\theta_S, \theta_W\} > \theta > \min\{\theta_S, \theta_W\}$ , the source firm allows (or disallows) technology transfer only when host economic rents are higher (or lower) under the technology transfer equilibrium.*

The relative position of  $\theta_W$  and  $\theta_S$  is key: the further apart they are, the smaller is the chance for conflict between the objectives of the source firm and the objectives of the host country. In general, the smaller the divergence between these two threshold values, the bigger the range where the two interests clash.

## 4 Choice of Entry Mode

Our basic model analyzes a situation where the source firm has already located its production facilities in the host country. We extend our basic model by adding a preliminary stage in which the source firm chooses between locating its production facilities in the host country or some alternative location

<sup>22</sup>This property need not always hold, but does if  $\Theta$  is sufficiently large, to generate a sufficiently large wage premium. We focus on this scenario, as it allows the richest set of conflict between the interests of the host government and the source firm.

(such as the source country or some third country).<sup>23</sup> The alternative location should be thought of as the best (lowest cost) alternative location. The rest of the model is as described earlier.

If the source firm chooses to produce in the alternative location, its marginal cost is the  $w_S^E$ . The possibility of technology transfer to the host firm is eliminated when producing in the alternative market. International labor mobility ensures that host firms cannot hire away the source firm's workers in other countries.<sup>24</sup> We call the choice of producing in an alternative location exporting, although the source firm is in fact exporting to the world market from whatever location it chooses (including the host country).

When making its decision between exporting and FDI, the source firm looks ahead and realizes that its own cost of production under FDI, as well as the cost of its rivals, depends upon whether or not it will find preventing technology transfer attractive. The source firm's problem of regime choice is summarized below:<sup>25</sup>

Table 1: Marginal Costs under Different Regimes

Regime	Source firm's cost	Host firm's cost
Exporting	$w_S^E$	$\Theta$
FDI with no technology transfer	$\Gamma$	$\Theta$
FDI with technology transfer	1	$\theta$

To derive the source firm's optimal decision, we first define the change in profits  $\Delta\pi_i^{jk} \equiv \pi_i^j - \pi_i^k$ , where  $i \in \{H, S\}$  refers to firms and  $j, k \in \{E, N, T\}$  refers to equilibrium regimes. Consider first the derivation of the locus  $\Delta\pi_S^{EN} \equiv \pi_S^E - \pi_S^N = 0$ , along which the source firm is indifferent between exporting and FDI with no technology transfer. Since under both regimes the host firm's marginal cost equals  $\Theta$ , the source firm prefers FDI with no technology transfer over exporting iff  $w_S^E > \Gamma$ . In  $(\theta, w_S^E)$  space, the equation  $w_S^E = \Gamma \equiv \frac{\Theta}{\theta}$  traces a downward sloping curve: above the curve the source firm prefers FDI with no technology transfer and below the curve exporting.

<sup>23</sup>A Japanese firm selling to the world market could export from Japan, where it does not fear technology transfer, or produce in China and export from there.

<sup>24</sup>For simplicity, the source firm is assumed to be the lone firm from this product market producing in the alternative location.

<sup>25</sup>Recall,  $\Theta \geq \theta \geq 1$ ,  $\Gamma \equiv \frac{\Theta}{\theta} \geq 1$  and  $w_S^E \geq 1$ .



Next consider the derivation of the locus  $\Delta\pi_S^{ET} \equiv \pi_S^E - \pi_S^T$  along which the source firm is indifferent between exporting and FDI with technology transfer. Above the curve, the source firm prefers FDI with technology transfer while below the curve exports. By the property that  $\pi_S^T > \pi_S^N$  iff  $\theta < \theta_S$ , the locus  $\Delta\pi_S^{EN}$  must lie above  $\Delta\pi_S^{ET}$  over the range  $\theta < \theta_S$ , with the positions reversed once the source firm threshold  $\theta_S$  is crossed.

Finally, consider the derivation of the locus  $\Delta\pi_S^{TN} \equiv \pi_S^T - \pi_S^N$  along which the source firm is indifferent between FDI with technology transfer and FDI with no technology transfer. Proposition 1 indicates that  $\Delta\pi_S^{TN}$  is a vertical line at  $\theta = \theta_S$  in the  $(\theta, w_S^E)$  space. To the left of this line, the source firm prefers FDI with technology transfer, while to the right FDI with no technology transfer. Since neither equilibrium being compared is exporting, the difference in profits is independent of the export cost.

**Lemma 3** *In  $(\theta, w_S^E)$  space, the locust of  $\Delta\pi_S^{ET} = 0$  is downward sloping and intersects the vertical axis below the locust of  $\Delta\pi_S^{EN} = 0$ . The locust  $\Delta\pi_S^{TN} = 0$  is a vertical line at  $\theta = \theta_S$ . These loci all intersect each other at  $(\theta_S, \hat{w}_S^E)$  and  $(1, \Theta)$  where  $\hat{w}_S^E \equiv \frac{\Theta}{\theta_S}$ .*

In Figure 3, the **SET** curve plots the locust of  $\Delta\pi_S^{ET} = 0$ , the **SEN** curve plots the locust of  $\Delta\pi_S^{EN} = 0$ , and the **STN** curve plots the locus of  $\Delta\pi_S^{TN} = 0$ .<sup>26</sup> When  $\theta \geq \theta_S$  (to the right of **STN**), FDI with no technology transfer dominates FDI with technology transfer. Thus, below the **SEN** curve the source firm opts for exporting as a method of preventing technology transfer, whereas above the curve it opts for paying a wage premium under FDI. When  $\theta < \theta_S$  (to the left of **STN**), FDI with technology transfer dominates FDI with no technology transfer. Thus, below the **SET** curve, the source firm opts for exporting whereas above the curve it opts for FDI with technology transfer. Thus the **SET**, **SEN** and **STN** curves divide the  $(\theta, w_S^E)$  space into three regions: exporting (when  $w_S^E$  is low), FDI with technology transfer (when  $w_S^E$  is high and  $\theta$  is low), and FDI with no technology transfer (when  $w_S^E$  is high and  $\theta$  is high).

<sup>26</sup>**SET** is darkened over  $\theta \in [1, \hat{\theta}_S)$  and dashed over  $\theta \in [\hat{\theta}_S, \Theta]$  while **SEN** is dashed over  $\theta \in [1, \hat{\theta}_S)$  and darkened over  $\theta \in [\hat{\theta}_S, \Theta]$  to emphasize only the boundaries of the regimes.

**Proposition 3** *If  $\theta \geq \theta_S$ , the source firm exports iff  $w_S^E < \Gamma$  or else engages in FDI and prevents technology transfer. When  $\theta < \theta_S$  the source firm exports iff  $w_S^E \leq \Omega$  or else engages in FDI and allows technology transfer.*

The *maximum exporting cost*  $\Omega$  (such that exporting dominates FDI with technology transfer) is defined as a function of  $\theta$  by<sup>27</sup>

$$\pi_S^E(\Omega, \Theta) = \pi_S^T(1, \theta) \leftrightarrow \Delta\pi_S^{ET} = 0 \quad (8)$$

Thus far we have identified parameter values that support exporting, FDI with no technology transfer, and FDI with technology transfer as equilibria based on the choice of the source firm. How does total economic rent in the host country depend upon the regime chosen by the source firm?

The preceding analysis indicates that the host economy is deprived of technology transfer either if the source firm chooses to export or pays a sufficient wage premium. Is the host economy therefore indifferent between exporting and FDI with no technology transfer? Does the host country always prefer FDI with technology transfer over FDI without it?

#### 4.1 Exporting versus FDI with No Technology Transfer

Suppose  $w_S^E = \Gamma$  and  $\theta > \theta_S$  so that the source firm is just indifferent between exporting and FDI with no technology transfer (any point on the **SEN** curve to the right of the **STN** curve in Figure 3). In either case, the source firm will have cost  $w_S^E = \Gamma$  while the host firm will have cost  $\Theta$ . However, since FDI with no technology transfer involves a positive wage premium, host economic rents are strictly higher under FDI with no technology transfer than under exporting. The interests of the host workers tip the balance in favor of FDI (with no technology transfer) over exporting. This result obtains even though the technology transfer, for which FDI is frequently sought by developing countries, is absent.

<sup>27</sup>Since the RHS is increasing in  $\theta$ , the LHS must also be increasing in  $\theta$ , which implies that  $\Omega$  is decreasing in  $\theta$ .

## 4.2 Exporting versus FDI with Technology Transfer

Next consider a comparison of exporting with FDI under technology transfer. This comparison is of substantial interest for its policy implications. Under both regimes, the source firm pays no wage premium. Thus, the only consideration is the fate of the host firm. Does FDI with technology transfer always dominate exporting in terms of host economic rents? Not necessarily.

In fact, the source firm may opt for FDI with technology transfer when host economic rents would be higher under exporting. Recall that the source firm prefers FDI with technology transfer to exporting above the **SET** curve in Figure 3. To examine host economic rents, we construct the **WET** curve which gives the locust of  $\Delta W^{ET} \equiv W^E - W^T = \pi_H^E - \pi_H^T = 0$  in the  $(\theta, w_S^E)$  plane. Using arguments very similar to those used in the proof of Lemma 2, the **WET** curve meets the **WEN** curve at  $(\Theta, 1)$ , and the vertical intercept of the **WET** curve is bigger than the vertical intercept of the **WEN** curve, as depicted in Figure 4. Figure 5 plots both the **WET** and the **SET** curves. Above the **WET** curve, the source firm chooses FDI with technology transfer but host economic rents are highest under exporting. In this **(T,E)** region, *FDI with technology transfer actually lowers host economic rents relative to exporting*.<sup>28</sup> Since  $w_S^E$  is high in this region, the source firm enjoys a substantial decline in its marginal cost if it switches from exporting to FDI, thereby adversely affecting the host firm's profits, despite the host firm enjoying technology transfer.

## 5 Policy Analysis

In developing countries, policies toward FDI have recently show a remarkable reversal: many countries that previously actively discouraged multinationals, now court them quite eagerly. This shift in policy is reflected in the explosion in the number of bilateral investment treaties that have been negotiated recently (United Nations, 1997).

While many elements could contribute to explaining why a developing country might be interested in attracting FDI, technology transfer is one of the dominant considerations, with higher wages another. Our model suggests

<sup>28</sup>For each region in Figure 5, the first letter is the source firm's chosen entry mode, and the second letter is the host country's preferred entry mode.

that the growing attractiveness of FDI is a natural consequence of trade liberalization ( $w_S^E$  falling) and greater absorptive capacity ( $\theta$  falling).

### 5.1 Inducing FDI with No Technology Transfer from Exporting

Suppose the parameter values are such that the source firm opts for exporting. Additionally, suppose  $\theta > \theta_S$  so that, if the source firm were to engage in FDI, it would not allow technology transfer. Would the host country want to *induce* FDI by the source firm? Even in this situation, the host country's economic rents can be increased by inducing FDI. From Proposition 3, when  $w_S^E = \Gamma$ , an arbitrarily small payment (either through a subsidy or a fixed up front payment) to the source firm on the condition that it produces in the host economy will increase economic rents.

The first rationale for attracting FDI suggested by our model is that the source firm increases wages for host workers. In general, when  $w_S^E < \Gamma$ , the minimum specific FDI inducing subsidy paid to the firm if it does FDI equals  $\sigma_m^N \equiv \Gamma - w_S^E$ . Under this subsidy, the profits of the host firm under FDI equal its profits under exporting. Similarly, the source firm has equal profits under the two regimes. Host workers, however, gain the amount  $(\Gamma - 1)q_S^N$ . Total subsidy payments equal  $(\Gamma - w_S^E)q_S^N$ . Thus, such a policy of inducing FDI increases economic rents because  $w_S^E > 1$ . The logic of this result is simple. Although the source firm is unwilling to undertake FDI if it has to pay the entire wage premium itself, it is quite willing to undertake FDI if it receives a subsidy from the host government. Host economic rents increase because some part of the source firm's cost savings from FDI are transferred over to host workers as higher wages.

### 5.2 Inducing FDI with Technology Transfer from Exporting

Again, suppose the parameter values are such that the source firm opts for exporting. But now suppose  $\theta < \theta_S$  so that, if the source firm were to engage in FDI, it would allow technology transfer. Now would the host country want to *induce* FDI by the source firm? In this situation too there exists a potential rationale for attracting FDI: the host firm enjoys technology transfer from

the source firm. To attract FDI, the host government can induce FDI by compensating the source firm for the loss in profits that FDI entails relative to exporting.<sup>29</sup> Under what circumstances does such a policy improve economic rents?<sup>30</sup>

Suppose the parameters lie exactly on the **SET** curve and to the left of the **STN** curve ( $\theta < \theta_S$ ) in Figure 3. Here the source firm is exactly indifferent between exporting and FDI with technology transfer, but the host country strictly prefers FDI with technology transfer (**WET** lies above **SET** in Figure 5). Again, a small incentive to FDI can yield an improvement in host economic rents, net of the subsidy payment. Here, the increase in host economic rents results from higher profits of the host firm.

### 5.3 Policy Contrast

While our model supports policies that encourage FDI, for some parameters discouraging FDI may be desirable for the host country. If both  $w_S^E$  and  $\theta$  are high, as may be for countries at low levels of development, the host government may try to discourage FDI; whereas if both  $w_S^E$  and  $\theta$  are low, as may be for countries at high levels of development, the host government may try to encourage FDI. A shift in policy toward encouraging FDI may occur as a country develops due to reductions in  $\theta$ : the potential for technology transfer becomes less partial in nature due to enhanced absorptive capacity.<sup>31</sup>

The upper range of  $\theta$  represents the lesser developed countries that host FDI from developed countries: their host firms are substantially disadvantaged relative to multinationals. In this upper range, multinationals undertake FDI but prevent technology transfer from occurring, while host governments want technology transfer (or exports) to occur. For the highest levels of  $\theta$ , where host firms would gain little from technology transfer if it were to occur (because it would be very partial in nature), benevolent governments may adopt policies prohibiting, or at least discouraging, FDI. A bit below that, host governments may take a more positive view of FDI, but conditional on multinationals generating technology transfer for host firms.

<sup>29</sup>This compensation could be done either by a flat payment upfront or by paying an output subsidy.

<sup>30</sup>Under FDI the source firm too enjoys a lower cost of production and the host firm could be worse off despite technology transfer.

<sup>31</sup>See also Glass and Saggi (1998a).

Since the multinationals still favor FDI with no technology transfer, conflict between the multinational and the host government remains.

In the middle range of  $\theta$ , a host country may experience blissful harmony with source firms, as both desire FDI with technology transfer. However, discord returns over the lowest ranges of  $\theta$ , which likely represent pairings of developed countries hosting FDI from other developed countries (the bulk of FDI). Here, source firms choose to export as a cheap way of protecting their technological advantage; however, the host country prefers FDI (with technology transfer initially and without as  $\theta$  approaches 1). In this range, policies to encourage FDI may arise.

## 6 Multiple Host Firms

How do our results change if the number of host firms is given by  $n - 1$ ,  $n \geq 2$ ? As in the basic model, assume that all host firms simultaneously choose the wage they offer to the informed workers, given the wage set by the source firm. Since all host firms are symmetric, we will restrict attention to a symmetric equilibrium.

A host firm's decision of whether or not to match the wage of the multinational is independent of the wage offered by other host firms. The point is that, given the marginal cost of production of its rivals, it is always in the interest of a host firm to minimize its own cost.<sup>32</sup> Thus, Lemma 1 applies to any host firm, regardless of the wage offered by all other firms. Consequently, given the wage of the source firm, either all host firms match its wage or none of them does.

To ease exposition, let the demand function be given by  $p = A - Q$ . Suppose the source firm offers a wage  $w = 1$ . From Lemma 1 it follows that all local firms match this wage, and given our assumptions of a perfectly elastic supply of uninformed workers coupled with instantaneous learning by workers, host firms face a perfectly elastic supply of informed workers. In such a situation, market competition at the next stage occurs between  $n - 1$  local firms whose marginal cost equals  $\theta$  and the source firm whose marginal

<sup>32</sup>Unlike the source firm, a host firm is incapable of affecting the decisions of other host firms since these are made simultaneously and because the informed workers are provided by the source firm.

cost equals 1. Source profits under technology transfer equal

$$\pi_S^T = \left[ \frac{A - n + (n - 1)\theta}{n + 1} \right]^2 \quad (9)$$

Now consider the scenario where the source firm pays the wage  $\Gamma$  and prevents technology transfer. Source profits under no technology transfer equal

$$\pi_S^N = \left[ \frac{A - n\Gamma + (n - 1)\Theta}{n + 1} \right]^2 \quad (10)$$

The source firm chooses to prevent technology transfer if  $\theta$  exceeds a new threshold

$$\pi_S^N \geq \pi_S^T \text{ iff } \theta \geq \frac{n}{n - 1} \quad (11)$$

Now, the threshold depends on the number of firms (or number of host firms).

**Proposition 4** *For the case of linear demand, the source firm threshold is  $\theta_S = \frac{n}{n-1}$ , where  $n$  is the total number of firms, with  $n - 1$  host firms and one source multinational.*

When  $n$  becomes very large, the source firm always prefers to restrict technology transfer.

$$\lim_{n \rightarrow \infty} \theta_S = 1 \quad (12)$$

With many local competitors, the benefit of restricting technology transfer is large since the source firm can increase the costs of all local competitors by paying a wage premium.

Regarding economic rents, we find that the host economy values technology transfer even more when multiple local firms compete with the source firm. If the number of host firms is large enough,

$$n > \hat{n} \iff W^T > W^N \quad (13)$$

then technology transfer is strictly preferred to no technology transfer in terms of host economic rents. As the number of host firms increases, technology transfer becomes more valuable since it lowers the costs of all host firms.

## 7 Conclusion

We have examined a market where a source firm possesses a superior technology relative to the host firm. If the source firm opts for FDI, technology may diffuse to the host firm as workers learn about the superior technology and thus become more productive if employed by the host firm. However, the source firm may be able to increase its profits by raising the wage it pays its workers sufficiently to discourage the host firm from hiring away some of its workers. Such a wage premium can raise profits by preventing the reduction in profits that would occur from the host firm hiring away workers informed with the new technology and thus becoming a tougher rival.

Our model implies that there could be two possible rationale for attracting FDI: technology transfer which increases firm profits or wage premiums that benefit workers. Since the two never occur together, an important conclusion is that developing countries cannot hope for both. On the positive side, countries are guaranteed of one if they can attract FDI. However, the realization of one of these benefits is insufficient to make FDI more attractive relative to exporting. Nevertheless, the host country can increase total rents earned by making the source firm switch to FDI through policy intervention (for some parameter values).



## A Appendix

### A.1 Proof of Lemma 1

Suppose the source firm offers a wage  $w_S$ . If the host firm offers the same wage, it can hire informed workers (technology transfer) or else it can offer the wage 1 and hire only uninformed workers. Under technology transfer its own marginal cost of production equals  $w_S\theta$  whereas that of the source firm equals  $w_S$ . Under no technology transfer, the costs of the two firms are  $w_S$  and  $\Theta$  respectively. The host firm matches the source firm's wage iff  $\pi_H^T(w_S, w_S\theta) > \pi_H^N(w_S, \Theta)$ . Note that  $\pi_H^T(w_S, \Theta)$  is strictly increasing in  $w_S$  and that when  $w_S = \Gamma$ ,  $\pi_H^T(w_S, w_S\theta) = \pi_H^N(w_S, \Theta)$ . Furthermore, at  $w_S = 1$ ,  $\pi_H^T(w_S, w_S\theta) > \pi_H^N(w_S, \Theta)$ . We only need to show that there exists no  $w_S \neq \Gamma$  such that  $\pi_H^T(w_S, w_S\theta) = \pi_H^N(w_S, \Theta)$ . First consider  $w_S = \Gamma - x$ ,  $x > 0$ . Then, at  $w_S = \Gamma - x$ ,  $\pi_H^T(w_S, w_S\theta) > \pi_H^N(w_S, \Theta)$ . Lastly, at  $w_S = \Gamma + x$ ,  $x > 0$ ,  $\pi_H^T(w_S, w_S\theta) < \pi_H^N(w_S, \Theta)$ . Thus, the unique intersection of  $\pi_H^T(w_S, w_S\theta)$  and  $\pi_H^N(w_S, \Theta)$  occurs at  $w_S = \Gamma$ ; for all  $w_S < \Gamma$ , we have  $\pi_H^T(w_S, w_S\theta) > \pi_H^N(w_S, \Theta)$  whereas for all  $w_S > \Gamma$ , we have  $\pi_H^T(w_S, w_S\theta) < \pi_H^N(w_S, \Theta)$ .

### A.2 Proof of Proposition 1

Suppose the source firm offers a wage  $w_S$  to its workers and the host firm matches that wage to attract informed workers. The marginal cost of the source firm is  $c_S = w_S$  and the marginal cost of the host firm is  $c_H = \theta w_S$ .<sup>33</sup> Clearly, a higher wage offered by the source firm raises the costs of both firms, provided the host firm continues to match the source firm's wage.

To simplify notation, in what follows, we denote  $p \equiv p(Q)$ ,  $p' \equiv p'(Q)$  and  $p'' \equiv p''(Q)$  and omit the superscripts on  $q_i$  that indicate optimal values. Differentiating the source firm's profit function (1) with respect to  $w_S$

$$\frac{\partial \pi_S}{\partial w_S} = \left[ p' \left( \frac{\partial q_S}{\partial w_S} + \frac{\partial q_H}{\partial w_S} \right) - 1 \right] q_S + \frac{\partial q_S}{\partial w_S} [p - w_S] \quad (14)$$

At the optimum, use the first order conditions (2) to obtain

$$\frac{\partial \pi_S}{\partial w_S} = q_S \left[ p' \frac{\partial q_H}{\partial w_S} - 1 \right] \quad (15)$$

<sup>33</sup>To be precise, the host firm has to offer a wage  $\epsilon$  higher than the source firm, but since  $\epsilon$  is arbitrarily close to zero, we can safely ignore it.

Therefore,  $p' \frac{\partial q_H}{\partial w_S} > 1$  is a necessary and sufficient condition for the source firm's profits to increase with the wage it pays. Differentiating the first order conditions (2) gives the following system

$$\underbrace{\begin{bmatrix} 2p' + q_S p'' & p' + q_S p'' \\ p' + q_H p'' & 2p' + q_H p'' \end{bmatrix}}_A \begin{bmatrix} \frac{\partial q_S}{\partial w_S} \\ \frac{\partial q_H}{\partial w_S} \end{bmatrix} = \begin{bmatrix} 1 \\ \theta \end{bmatrix} \quad (16)$$

where  $|A| = p' [3p' + p''(q_H + q_S)] > 0$  as  $p' < 0$  and  $p'' < 0$ . Using Cramer's rule,

$$\frac{\partial q_H}{\partial w_S} = \frac{(2p' + q_S p'') \theta - (p' + q_H p'')}{|A|} < 0 \quad (17)$$

since  $\theta > 1$ . Using (15) and (17),

$$\frac{\partial \pi_S}{\partial w_S} = q_S \left[ \frac{p' [(2p' + q_S p'') \theta - (p' + q_H p'')]}{|A|} - 1 \right] \quad (18)$$

which simplifies to

$$\frac{\partial \pi_S}{\partial w_S} = \frac{2 \overbrace{(p')^2}^+ (\theta - 2) + \overbrace{p'' p'}^+ [q_S(\theta - 1) - 2q_H]}{|A|} \quad (19)$$

where  $|A| > 0$ . Sufficient conditions to ensure that the source firm's profits increase with the wage it pays are  $\theta - 2 > 0$  and  $q_S(\theta - 1) - 2q_H > 0$ . Since  $q_S > q_H$ , both conditions hold when  $\theta > 3$ . Furthermore, in the limit as the host firm's disadvantage disappears  $\theta \rightarrow 1$ , the source firm's profits decrease with its wage. By continuity, the source firm's profits must remain unchanged by an increase in its wage for some threshold  $\theta_S$ , with  $1 < \theta_S < 3$ .

Similarly, differentiating the host firm's profit function (1) with respect to  $w_S$

$$\frac{\partial \pi_H}{\partial w_S} = \left[ p' \left( \frac{\partial q_S}{\partial w_S} + \frac{\partial q_H}{\partial w_S} \right) - \theta \right] q_H + \frac{\partial q_H}{\partial w_S} [p - \theta w_S] \quad (20)$$

At the optimum, use the first order conditions (2) to obtain

$$\frac{\partial \pi_H}{\partial w_S} = q_H \left[ p' \frac{\partial q_S}{\partial w_S} - \theta \right] \quad (21)$$

Using Cramer's rule

$$\frac{\partial q_S}{\partial w_S} = \frac{(2p' + q_H p'') - \theta (p' + q_S p'')}{|A|} \quad (22)$$

Using (21) and (22)

$$\frac{\partial \pi_H}{\partial w_S} = q_H \left[ \frac{p' [(2p' + q_H p'') - \theta (p' + q_S p'')]}{|A|} - \theta \right] \quad (23)$$

which simplifies to

$$\frac{\partial \pi_H}{\partial w_S} = \frac{2 \overbrace{(p')^2}^- (1 - 2\theta) + \overbrace{p'' p'}^+ \overbrace{(q_H (1 - \theta) - 2\theta q_S)}^-}{|A|} < 0 \quad (24)$$

This inequality is true for all values of  $\theta$  (greater than one by assumption) and follows from the productivity disadvantage suffered by the host firm. Thus, the host firm always enjoys higher profits under technology transfer.

### A.3 Proof of Lemma 2

First, we show that the **SET** curve is downward sloping in the  $(\theta, w_S^E)$  space. Along the **SET** curve,  $\pi_S^E(w_S^E, \Theta) = \pi_S^T(1, \theta)$ . The right hand side is increasing in  $\theta$  while the left hand side is unaffected. Thus, for the two to stay equal, as  $\theta$  increases,  $w_S^E$  must decrease.

Second, we show that the **SEN** curve intersects the vertical axis above the **SET** curve. The **SEN** curve intersects the vertical axis at  $\Theta$ . Let the **SET** curve intersect the vertical axis at some  $\tilde{w}_S^E$ , the wage where the source firm is indifferent between exporting and FDI with no technology transfer at  $\theta = 1$ . We claim  $1 < \tilde{w}_S^E < \Theta$ . The logic as follows. Since at  $\theta = 1$ ,  $\pi_S^N(\Gamma, \Theta) = \pi_S^N(\Theta, \Theta) < \pi_S^T(1, 1)$ , it must be that  $\pi_S^E(\Theta, \Theta) < \pi_S^T(1, 1)$ . Therefore, since  $\pi_S^E(w_S^E, \Theta)$  is decreasing in  $w_S^E$ ,  $\pi_S^E(\tilde{w}_S^E, \Theta) = \pi_S^T(1, 1)$  iff  $\tilde{w}_S^E < \Theta$ . Lastly,  $1 < \tilde{w}_S^E$  because at  $w_S^E = 1$ ,  $\pi_S^E(1, \Theta) > \pi_S^T(1, 1)$ .

Third, we show that the **SEN** curve and the **SET** curve intersect at  $(\theta, \hat{w}_S^E)$  as well as at  $(\Theta, 1)$ , where  $\hat{w}_S^E \equiv \frac{\Theta}{\theta_S}$ . At  $\theta = \Theta$ ,  $\pi_S^N(\Gamma, \Theta) = \pi_S^N(1, \Theta) = \pi_S^T(1, \theta)$ . Further, at  $\theta = \Theta$  and  $w_S^E = 1$ , we have  $\pi_S^N(\Gamma, \Theta) = \pi_S^E(1, \Theta)$ . Suppose  $\theta = \theta_S$ , by definition at  $\theta = \theta_S$ , we have  $\pi_S^N(\Gamma, \Theta) = \pi_S^T(1, \theta)$ . Subtracting  $\pi_S^E(\hat{w}_S^E, \Theta)$  from both sides of the equation implies that at  $\theta = \theta_S$ , we must have  $\Delta\pi_S^{EN}(\Gamma, \Theta) = \Delta\pi_S^{ET}(1, \theta)$ , so the **SEN** and **SET** curves must intersect at  $\theta = \theta_S$ .

#### A.4 Proof of Lemma 3

Differentiating host firm profits with respect to  $\theta$

$$\frac{d\pi_H^N}{d\theta} = p'(Q^N) \left[ \frac{\partial q_H^N}{\partial \theta} + \frac{\partial q_S^N}{\partial \theta} \right] q_H^N + [p(Q^N) - \Theta] \frac{\partial q_H^N}{\partial \theta} \quad (25)$$

Rearranging and making use of the first order conditions (2), the total effect of a change in  $\theta$  (the host firm's disadvantage) on host firm profits is negative.

$$\frac{d\pi_H^N}{d\theta} = \overbrace{p'(Q^N)}^{-} \overbrace{\frac{\partial q_S^N}{\partial \theta}}^{+} q_H^N < 0 \quad (26)$$

Next consider the effect of a change in  $\theta$  on the wage premium paid to workers

$$\frac{dB^N}{d\theta} = \frac{\Theta}{\theta} \left( \frac{\partial q_S^N}{\partial \theta} - \frac{q_S^N}{\theta} \right) - \frac{\partial q_S^N}{\partial \theta} < 0 \text{ if } \frac{\partial q_S^N}{\partial \theta} < \frac{q_S^N}{\theta} \quad (27)$$

$$\frac{dB^N}{d\theta} = \overbrace{-\frac{\Theta}{\theta^2} q_S^N}^{-} + \overbrace{\left( \frac{\Theta}{\theta} - 1 \right) \frac{dq_S^N}{d\theta}}^{+} \quad (28)$$

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Figure 1: Source Profits  
and Technology Transfer

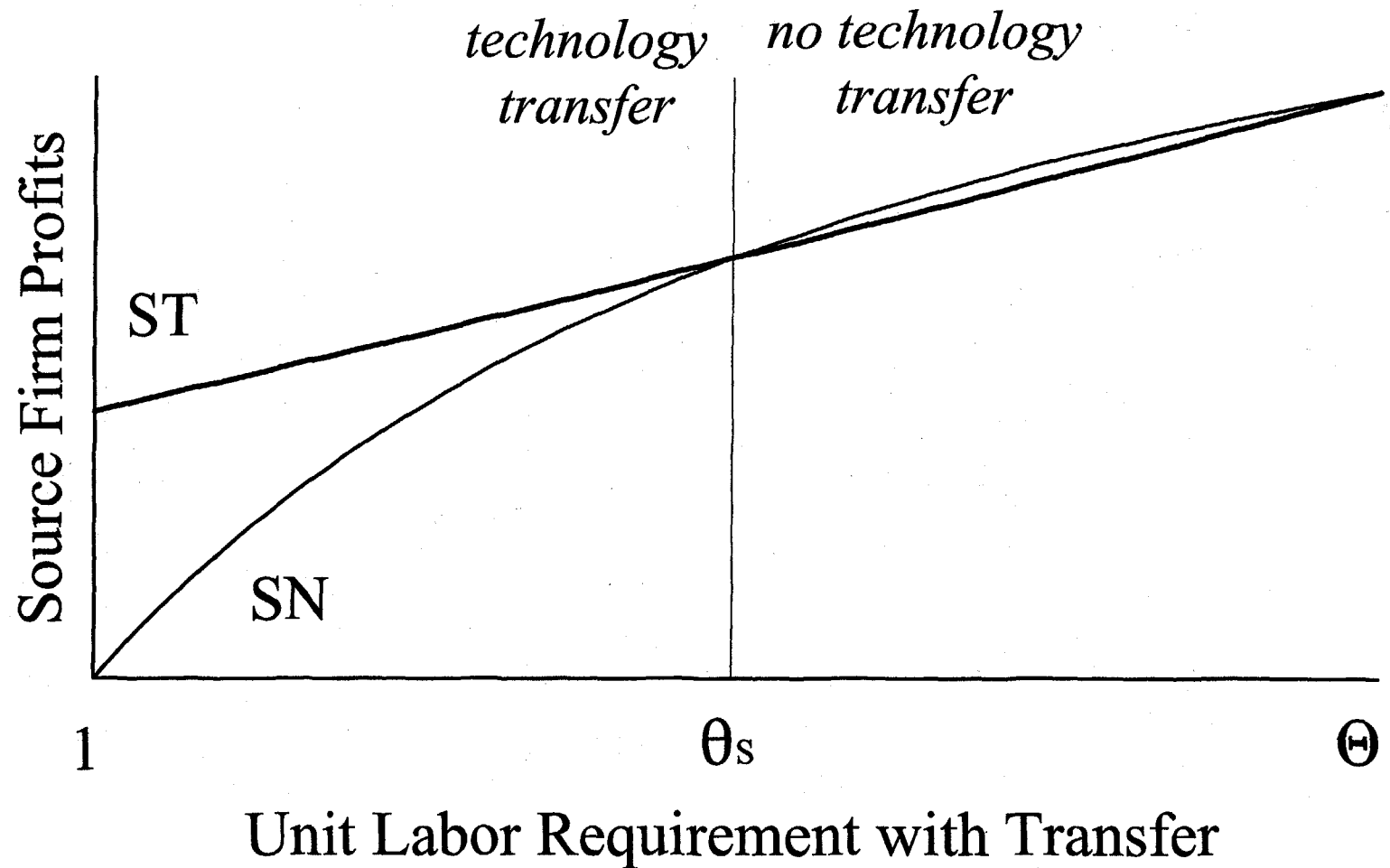


Figure 2: Host Welfare  
and Technology Transfer

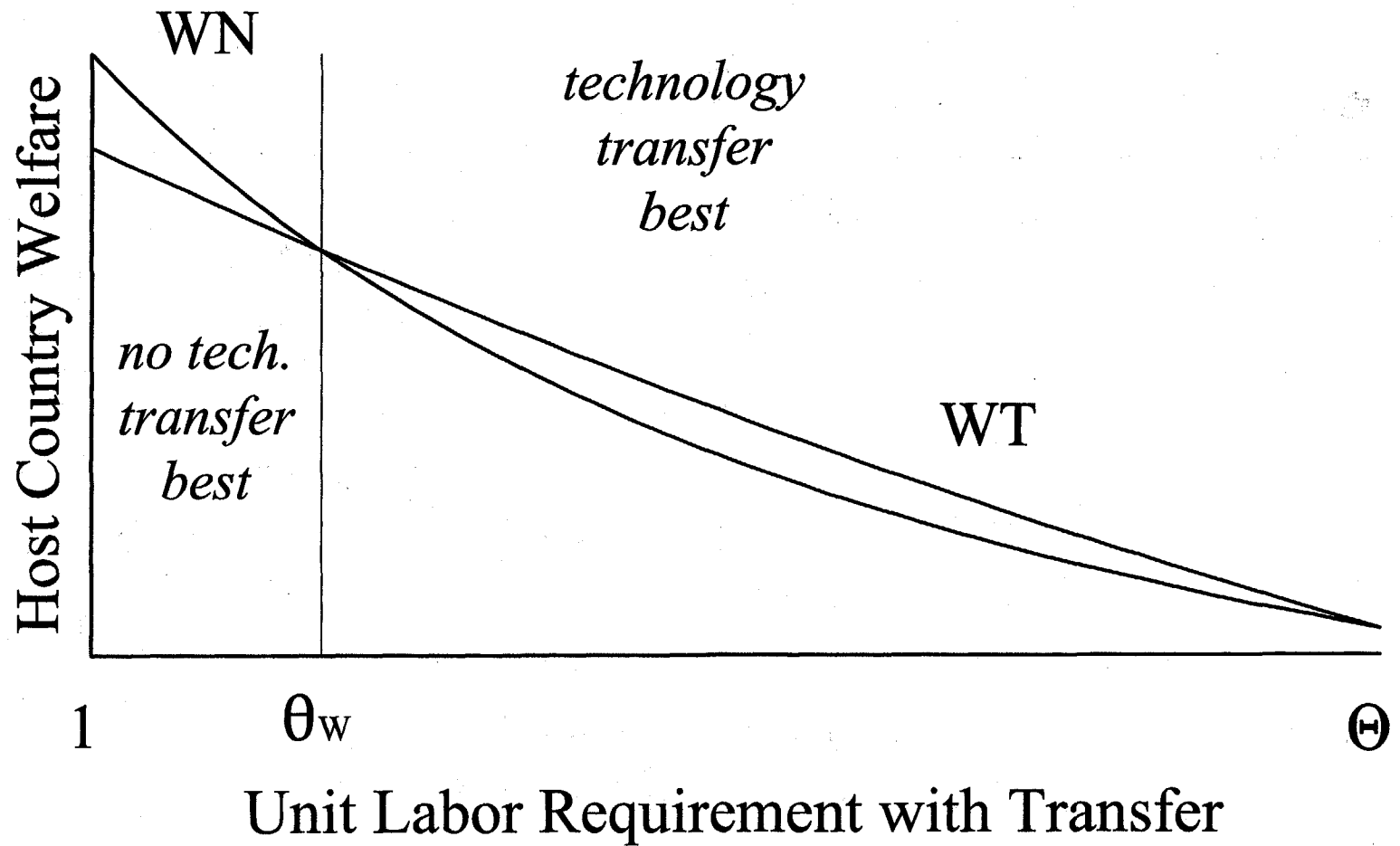




Figure 3: Source Firm  
Chosen Entry Mode

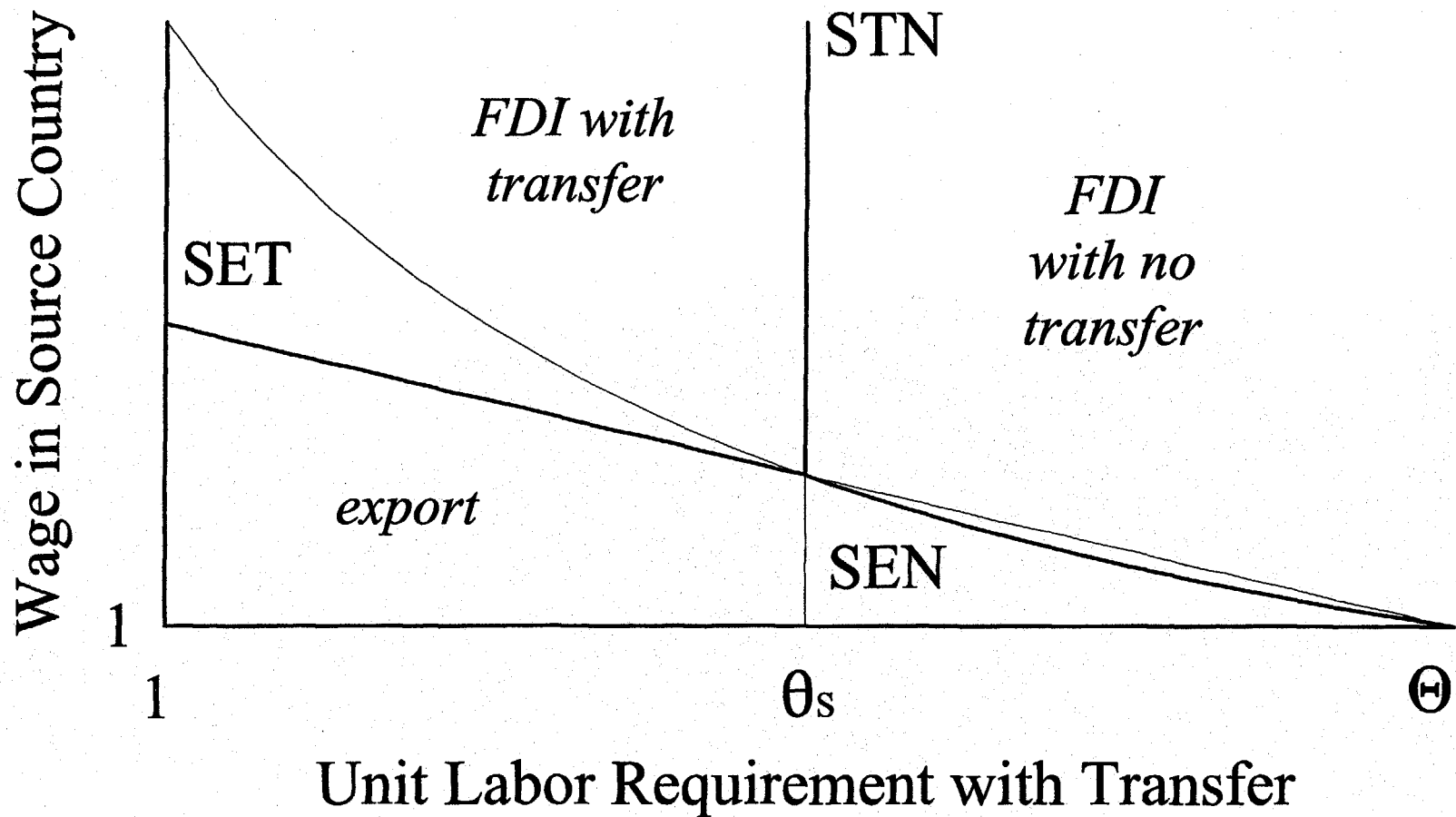


Figure 4: Host Country  
Preferred Entry Mode

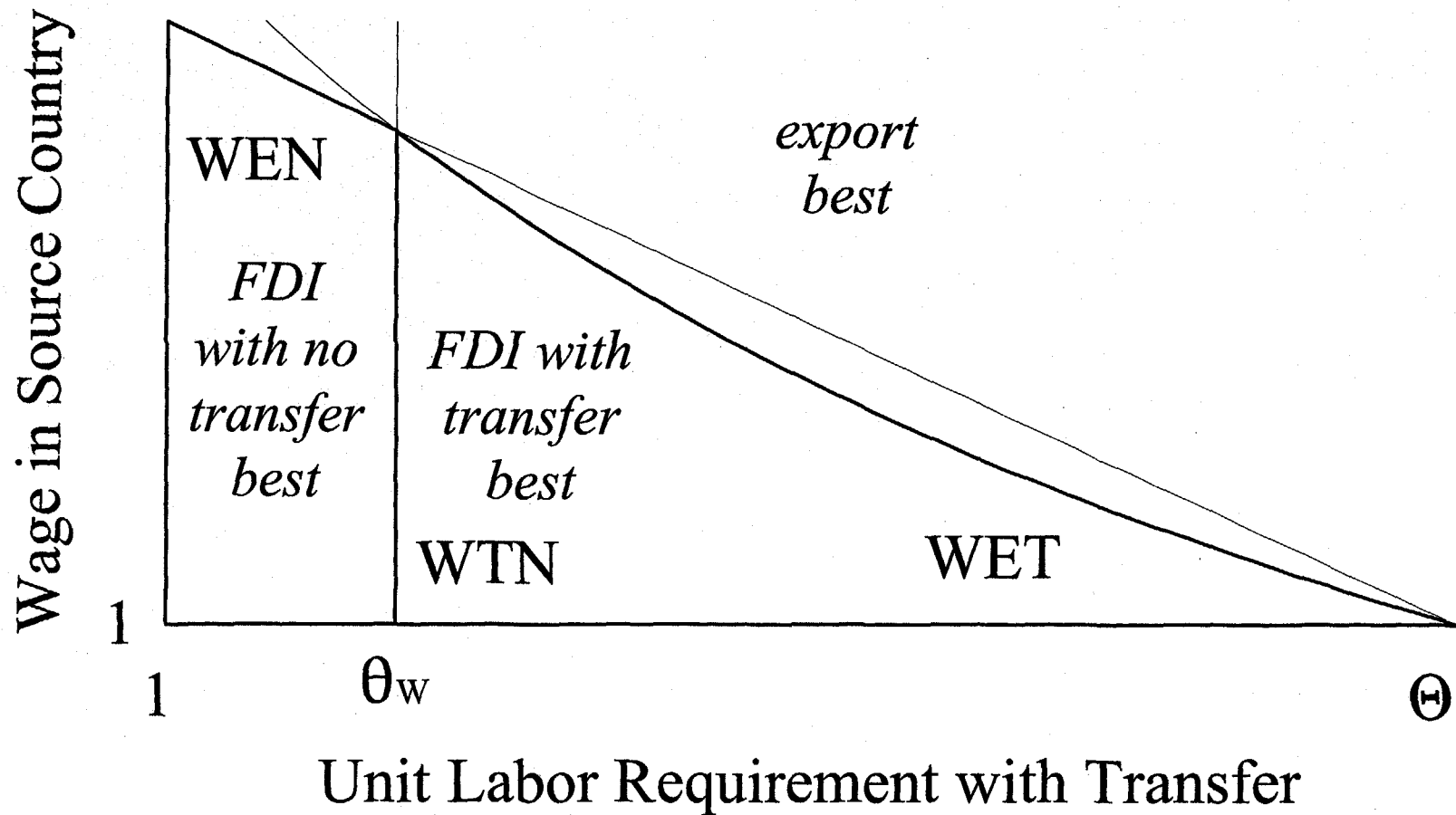
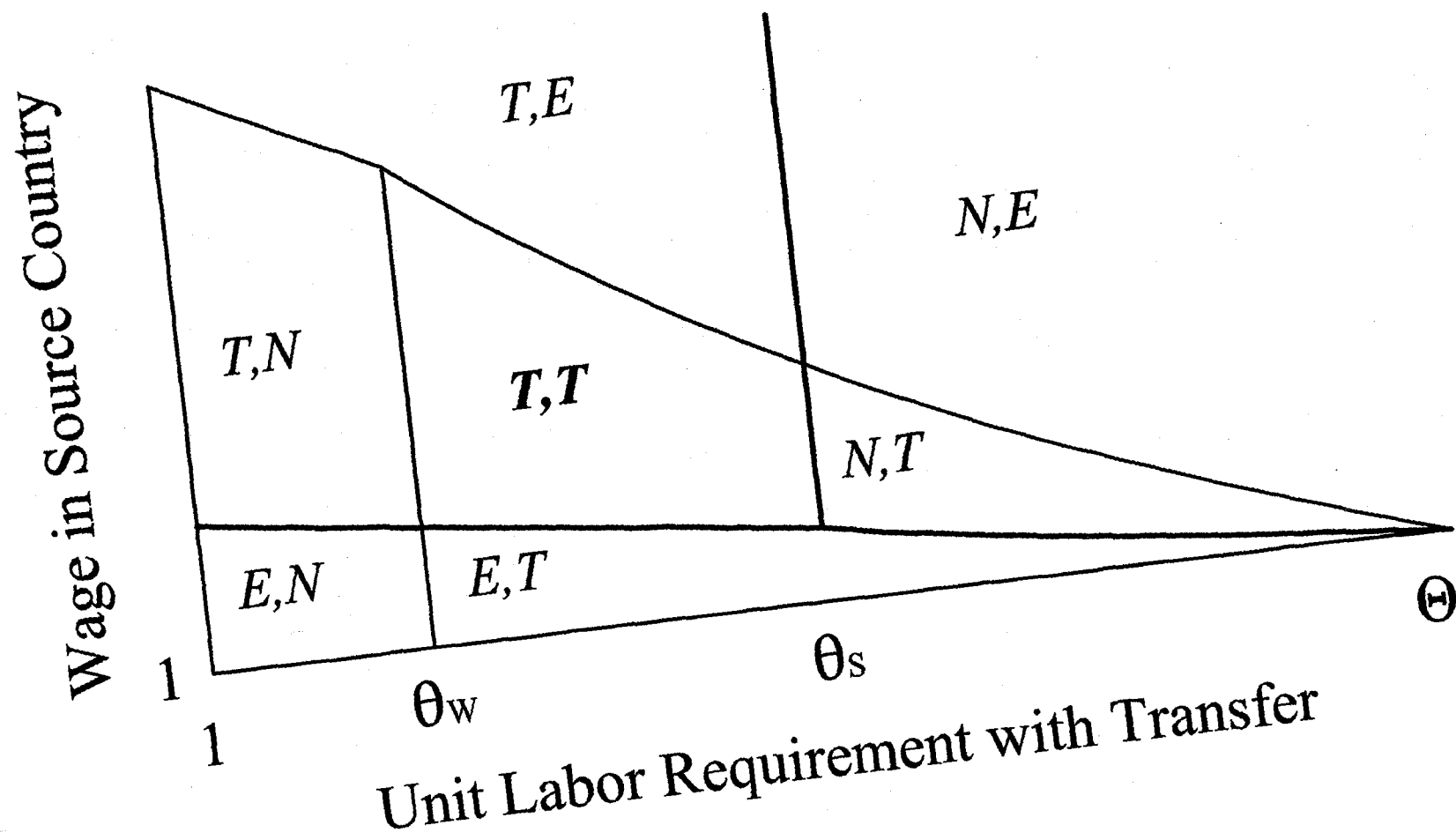


Figure 5: Conflict between  
Source Profits and Host Welfare



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